PRE-CONFERENCE TUTORIAL

26th Norchip Conference

16 November 2008 at 13.00-17.00, Tallinn, ESTONIA

Lab-on-Chip Based Sensors for bioparticles detection and characterisation

Abstract

Laboratory-on-Chip (LoC) is an advanced multidisciplinary research approach calls for an integration of heterogeneous structures including microelectronic and microfluidic technologies as well as conventional biochemistry techniques. Standard CMOS process is an excellent candidate to realize such LoC systems offering the advantages of well-studied circuits and embedded sensors/actuators. This tutorial presents an overview of recent advances in the design and implementation of hybrid microfluidic CMOS systems for LoC applications. A CMOS-based LoC can be divided in three parts : microfluidic structure, biofunctionalized layers (transduce the biological quantities to electrical changes or vice versa) and microelectronic circuitry. Through this technology several embedded sensing techniques can be realized as reported in the literature. In this tutorial, the optical, thermal, ISFET, impedimetric and in particular capacitive sensors are presented for molecular/cellular applications.

Outline:

13.00 Overview
13.10 Smart Medical Devices for Diagnostics Purpose
13.30 On-Chip microfluidic Packaging
13.50 Biofunctionalized Layers of CMOS chips
14.10 Coffee break
14.40 Biofunctionalized Layers of CMOS chips
a. Actuators (Magnetic, Electrical)
b. Sensors (Optical, Capacitive, ISFET, Thermal)
16.20 Direct-write CMOS based Lab-on-Chip
16.30 Summary

Sample publications by the Authors:

[1] SAWAN, M., GHAFAR-ZADEH, E., "A 0.18 µm CMOS Capacitive Detection Lab-on-Chip", Invited Talk at IEEE-CICC, San Jose, September 2007.

[2] SAWAN, M., "Diagnostic tools based on mixed-technology microdevices", Tutorial ECCDT2007, Sevilla, Spain, August 2007.

[3] GHAFAR-ZADEH, E., SAWAN, M., "A Hybrid Microfluidic/CMOS Capacitive Sensor Dedicated to Lab-on-Chip Applications", IEEE Transactions on Biomedical Circuits & Systems, Dec. 2007.

[4] GHAFAR-ZADEH, E., SAWAN, M., THERRIAULT, D., "Novel Direct-Write CMOS-based Laboratory-On-Chip: Design, Assembly and Experimental Results", *Elsevier Sensors & Actuators*, Available online, 2006, 10 pages.

Mohamad Sawan received his BSc in Electrical Engineering from Université Laval (1984), and MSc (1986) and PhD (1990) both in Electrical Engineering from Université de Sherbrooke. He then completed post-doctoral training at Montréal's McGill University in 1991, and in that same year, joined École Polytechnique de Montréal, where he is currently a Professor of Microelectronics. Dr. Sawan's scientific interests focus on the design and testing of mixed-signal (analog, digital and RF) circuits and systems; digital and analog signal processing; and the modelling, design, integration, assembly and validation of advanced wirelessly powered and controlled monitoring and measurement techniques. These topics are oriented toward biomedical implantable devices and telecommunications applications. Dr. Sawan is holder of the Canada Research Chair in Smart Medical Devices. He heads the Microsystems Strategic Alliance of Québec – ReSMiQ and is founder of the Eastern Canada Chapter of the IEEE-Solid State Circuits Society. He also founded the International IEEE-NEWCAS conference, co-founded the International Functional Electrical Stimulation Society, and founded the Polystim Neurotechnologies Laboratory at Ecole Polytechnique. He is the editor of Springer mixed-signal letters, Chair of the IEEE Biomedical CAS (BioCAS) Technical Committee, and member of the Biotechnology Council representing the IEEE-CAS Society. He has been awarded seven patents. He received the Barbara Turnbull Award for spinal cord research, the Medal of Merit from the Lebanese President (2005), and the J.-A. Bombardier Award from the Association Francophone pour le savoir (ACFAS). Dr. Sawan is a Fellow of the Canadian Academy of Engineering, the IEEE and Engineering Institute of Canada.

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